Mint Farming

Farmers' Bulletin No. 1988

U. S. DEPARTMENT OF AGRICULTURE

Contents

Cover illustration . . . Typical specimen of peppermint; inset, mint field showing second-year meadow mint on left and first-year row mint on right.

Washington, D. C. Revised February 1954

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price 15 cents

MINT FARMING

Prepared by the *Section of Tobacco, Medicinal, and Special Crops, Field Crops Research Branch, Agricultural Research Service*[1]

THE CULTURE of peppermint and spearmint in a few well-defined areas of the Central and Pacific States provides most of the world's supply of peppermint and spearmint oils. These essential oils are the principal marketable products of the two crops, although there is a limited use for the fresh and dried herb as a condiment.

The requirement for mint oils has been and probably will continue to be steady and relatively inelastic owing to their limited number of uses. Peppermint oil, the more important of the two, is used chiefly for flavoring chewing gum, candy, and toothpaste, and to a lesser extent to mask the flavor and odor of numerous medicinal products. Spearmint oil is in less demand, because its use has been confined largely to flavoring chewing gum, and to a smaller extent for flavoring toothpaste.

Mint is grown principally on muck and fertile sandy-loam soils in Indiana, Michigan, Oregon, Washington, Wisconsin, California, and Ohio (fig. 1), where conditions are especially favorable to the crop. In 1952 about 43,000 acres of peppermint and 15,000 acres of spearmint were under cultivation. The 1941–50 acreage and yield, by States, are shown in table 1.

Mint is quite susceptible to unfavorable weather, which causes considerable variation in the oil yield per acre, from year to year. It is also susceptible to disease. Nevertheless, where handled properly as an established part of the farming operation, mint brings fair returns.

An important feature of mint farming is the removal of oil from the hay by steam distillation, for which special equipment is needed. The processing operation on the farm marks this as a specialized industry. The relatively large investment in equipment, generally of no other use on the farm, places the short-term operation at a disadvantage. Mint must compete with other intensive crops for use of fertile and valuable land and to meet its rather large labor requirements. These factors discourage the in-and-out operator and set fairly definite limits—both minimum and maximum—on the individual grower's scale of operations; they also

[1] This bulletin was originally prepared by A. F. Sievers, formerly principal biochemist, and E. C. Stevenson, formerly pathologist; present revision is by L. M. Pultz, principal horticulturist, Section of Tobacco, Medicinal, and Special Crops. Acknowledgment is made to members of the State agricultural experiment stations in Indiana, Michigan, Oregon, Washington, and California for their cooperation; in particular to N. Kent Ellis of the Purdue University Agricultural Experiment Station.

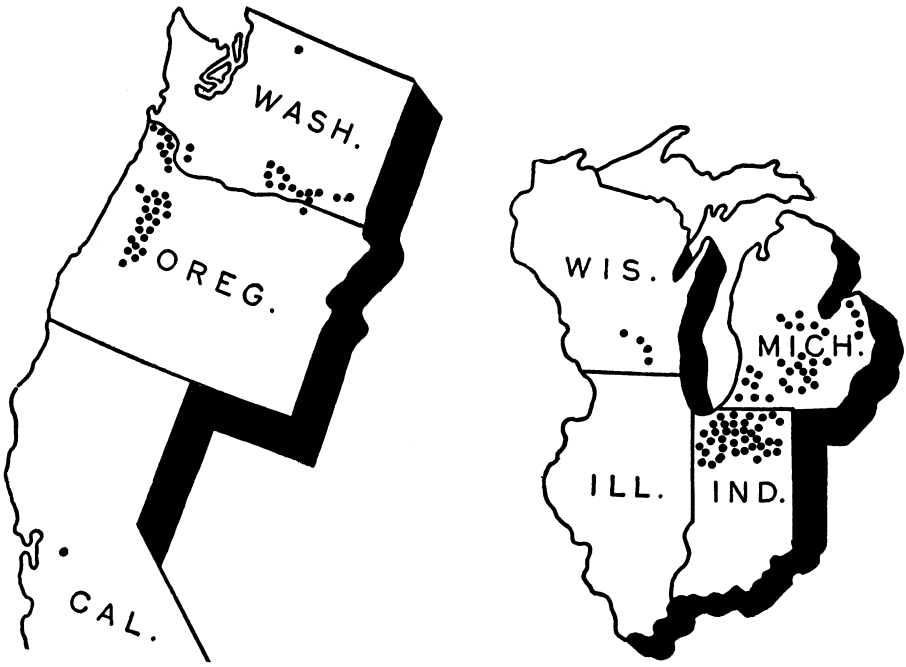

FIGURE 1.—The principal mint-producing areas of the United States in 1952. Each dot represents approximately 500 acres.

TABLE 1.—*Acreage of mint and yield of mint oils in the United States*

[Averages for 1941–50 and actual acreage and yield for 1951 and 1952]

PEPPERMINT

State	Area in production			Yield of oil per acre		
	Average 1941–50	1951	1952	Average 1941–50	1951	1952
	Acres	*Acres*	*Acres*	*Pounds*	*Pounds*	*Pounds*
Indiana	16, 150	11, 300	9, 700	28. 4	32. 0	29. 5
Michigan	13, 030	10, 000	9, 000	22. 0	20. 0	23. 0
Wisconsin	[1] 630	1, 800	2, 000	[1] 35. 0	34. 0	35. 0
Oregon	8, 620	14, 000	15, 000	44. 0	38. 0	48. 0
Washington	4, 160	7, 100	7, 500	48. 2	68. 0	69. 0
Total or average	42, 590	44, 200	43, 200	31. 6	37. 1	41. 7

SPEARMINT

Indiana	8, 210	6, 800	8, 900	33. 2	34. 0	35. 0
Michigan	3, 730	4, 700	5, 900	34. 5	30. 0	28. 0
Washington			450			70. 0
Total or average	11, 940	11, 500	15, 250	33. 5	32. 3	33. 3

[1] Average for 3 years, 1948–50, only.

Bureau of Agricultural Economics, U. S. Department of Agriculture.

Note: A small amount of peppermint was grown in Ohio and California, and spearmint in California in addition to that shown in the table.

rule out the small operators, other than those who can use their neighbors' distillation equipment.

The adaptation of mints to local soils and climatic conditions and the cost of labor required should be carefully considered before undertaking mint culture. The prospective mint farmer should make a careful study of all the costs of erecting a still before growing this crop, particularly in a locality where there are no other mint producers with whom arrangements could be made for distillation.

MINT-PRODUCING AREAS

Commercial peppermint culture was introduced into the United States about 1812, at Ashfield, Mass., and by 1825 several hundred acres were under cultivation there. About 1816 the crop became established in Wayne County, N. Y., and from there its culture extended westward, first to northern Ohio and later to southern Michigan, where in 1835 the first plantings were made in St. Joseph County. The success of this venture led to the extension of the industry into southwestern Michigan and the northern counties of Indiana. The large areas of muck soil were found to be so well adapted to mint culture that this region soon became the center of production.

The Michigan-Indiana district continued to be the major mint-producing area in the United States until about 1940 when the acreage in Michigan began to decline as a result of crop losses caused by verticillium wilt (page 13). More recently the same disease has been a factor in the reduction of mint acreage in Indiana.

Commercial peppermint culture has recently become established in southern Wisconsin, mainly in Jefferson County. In 1949 there were 500 acres of mint in the State, and by 1952, 2,000 acres. Plantings in the eastern United States have been gradually reduced until at present there are less than 100 acres in Ohio and none in New York.

Success in peppermint culture on the muck lands of the Middle West naturally led to experimental plantings in other parts of the country having similar soils. About 1909 it was found that the soil and climate were favorable in parts of western Oregon and Washington. The crop was soon introduced along the Willamette River in Oregon, on both sides of the Columbia River, and on the islands from Portland west. The crop has become firmly established in the irrigated districts in the Yakima Valley of Washington from Yakima east to the Kennewick area. The mint acreage in Washington and Oregon has increased so rapidly in recent years that by 1952 the production of oil in these two States was more than double the production in Indiana and Michigan.

Spearmint is grown commercially in the Michigan-Indiana district and to a limited extent in Washington. The acreage is much smaller than that of peppermint.

DESCRIPTION AND TYPES OF MINTS

The mints are perennial plants with square stems. They bear oil in glands, mostly on the undersurface of the leaves. The plants produce profuse blooms, but the commercial varieties rarely set seed. They reproduce readily, however, by means of stolons. These stolons are specialized stems that grow under and on the surface of the soil and provide a means by which the plants spread. The stolons spread in all directions near the surface of the ground, take root, and send up new growth at the nodes or joints. Sections of stolons or the new

shoots may be planted to start a new field.

Mint plants grow to a height of 3 feet, and even higher if the soil is rich and they are crowded. When grown in rows or kept sufficiently thinned out, the plants develop numerous side branches and assume a bushy character.

Peppermint (*Mentha piperita*) occurs as three important horticultural varieties, usually referred to as black, white, and American (fig. 2). All three yield the peppermint oil of commerce, but they differ somewhat in appearance, growth habit, and adaptability to the cultural conditions found in this country.

Black peppermint (also commonly known as black mint, English peppermint, and Mitcham mint) is the variety most extensively grown. The term "Mitcham" has been applied rather loosely at times by growers and writers to several different types of mint, since the early introductions of peppermint came from a district in England known as Mitcham. Black peppermint gives the best yields and is relatively more hardy than the others. It has dark-purple stems and deep-green, broadly lanced, slightly toothed leaves. The flowers are light purple and are produced in terminal spikes.

White peppermint (known also as white mint, Mitcham mint, and white Mitcham) is not cultivated commercially in the United States at present, but is still grown to some extent in England. It is less hardy and productive than the black peppermint, but it has been claimed that it yields a finer oil. White peppermint is smaller than the black peppermint and has green stems and light-green, slightly pointed, deeply toothed leaves.

American peppermint (known also as American mint and State mint) was probably the first variety grown in the United States. It is similar to black peppermint, but has green stems and lighter green leaves. Although this variety is very hardy, it yields less oil than the black mint and therefore is of little commercial value and should be excluded from cultivation.

Both the common spearmint (*Mentha spicata*) and a horticultural variety of it known as Scotch spearmint are grown (fig. 3). Both have some of the characteristics of peppermint but can be distinguished readily from it. Common spearmint has longer, lighter green leaves and more slender flower spikes. Scotch mint is more pubescent (hairy) and has its flowers in whorls in the leaf axils. It has largely replaced the common type in commercial plantings because it has greater vigor and productiveness.

Japanese mint (*Mentha arvensis* var. *piperascens*) is a rich source of menthol, very different from peppermint and spearmint oils. The Federal Food, Drug, and Cosmetics Act requires that products containing Japanese mint oil be labeled "flavored with corn mint" or "flavored with field mint." This plant is often erroneously called "Japanese peppermint," but should not be confused with true peppermint. Large quantities of Japanese mint are grown in Japan and Brazil, but only a limited amount is grown in the United States. Information about its culture can be obtained from the Section of Tobacco, Medicinal, and Special Crops, Plant Industry Station, Beltsville, Maryland.

A number of forms of native mint occurring naturally in many parts of the United States contain oil, but it is of poor quality. These plants have no commercial value, and if mint culture is to be undertaken on land where they occur they must first be thoroughly eradicated before the commercial variety is planted; if allowed to remain to any

FIGURE 2.—Peppermint, showing characteristic leaves and flowers.

FIGURE 3.—Spearmint, showing typical flowers and leaves: Left, Scotch mint, and right, common mint.

considerable extent they will lower the quality of the oil obtained.

CULTURE

Mint is a gross feeder, a vigorous speader owing to the lateral growth of stolons and sprouting of plants from its stolons, and persistent even when plowed under. It is often grown as a row crop the first year and then allowed to spread over the field in subsequent years into a solid stand spoken of as "meadow mint" (see inset on cover). This facilitates spread of both weeds and disease. Weeds, particularly perennial grasses, are difficult to destroy after mint has spread beyond the planted rows. Although the same planting may be kept for several years it is more profitable in most cases to keep it for only 2 years. The yield decreases and weeds and diseases increase as the stand gets older.

In the irrigated sections of the West mint is grown only as a row crop. The same field may remain in mint for several years but each fall the old planting is shallowly plowed and the rows defined in the spring, or the original row is removed in the spring with a potato digger, the field leveled by harrowing and the new row then becomes what was the center between the old rows of the year before.

When a mint stand is abandoned, it is generally followed by a crop that can be planted in hills for cross-cultivation to eradicate both weeds and mint. Corn is often used as a crop following mint since it is difficult to eradicate mint from such row crops as carrots and onions.

SOIL REQUIREMENTS

Mints can be grown on a wide range of soil types, but do best on deep, rich soil that has fairly loose texture and permits easy root penetration. An abundance of humus is desirable. The soil should range from mildly acid to neutral or barely alkaline. The preferred pH range is between 6.0 and 7.5. This is based on a standard system of evaluation in which alkalinity is measured upward and acidity downward, from the neutral point, pH 7.0. A very acid soil may require the application of ground limestone before it can be used for mint production. The soil should also be well drained but of a type that does not become too dry. Land that contains a large proportion of clay is usually unsatisfactory.

Suitable growing conditions are most readily available in the well-drained muck soils used for celery, onions, cabbage, and similar crops that require the quickly available soil elements necessary to produce strong and rapid growth. As a rule, drained muck lands also offer another advantage—the possibility of controlling the water level by the use of gates in the drainage ditches. Where possible, the water table should be held at about 2 feet from the surface until just prior to cutting time, when it is advisable to lower it to 30 or 36 inches. Deep fertile upland soils of sandy or gravelly loam texture that will produce potatoes and corn are also reasonably suitable for mint culture.

Next in desirability from the standpoint of soil alone, but more important in terms of acreage and production, are the sandy-loam soils of the Pacific Northwest. They are found on the low tableland that lies adjacent to the Willamette River bottoms in Oregon, and in the irrigated districts of the Yakima Valley in Washington. Like the muck soils, the Willamette Valley soils are drained by ditches and, being subject to spring overflows, are also protected from the river in most cases by dikes. With good cultural practices, they are well adapted to mint production.

281698°—54——2

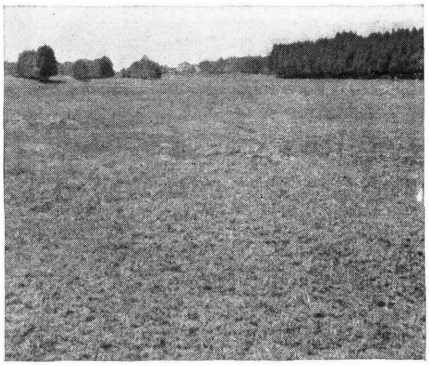

FIGURE 4.—Willow windbreaks in a harvested mint field in northern Indiana.

Mint farming under irrigation was introduced in the Yakima Valley, Washington, on lands previously used for alfalfa and fruit. Mint has been planted extensively in the several irrigation districts from Yakima in the south-central part of the State as far east as the Kennewick district. The soil in this region is mainly sandy-loam, but some plantings have been made on clay-loam.

The level stretches of muck land in Michigan and Indiana, while ideal as to soil, are subject to severe winds of several days' duration in spring. In the absence of occasional stands of timber or windbreaks, such as are shown in figure 4, when such winds follow a prolonged drought the sand blows and may severely damage the tender plants. In such a situation windbreaks are planted, usually of willow, in north-south rows, with an occasional east-west row. Strip-cropping the field at intervals with rye will protect somewhat the first-year mint.

PREPARATION OF THE SOIL

Because weed infestation is a serious danger, mint should follow a clean-tilled crop or the land should be plowed and left fallow in the preceding summer or early fall. In either event, the land should be worked for as long a period as possible before planting; this reduces the weeds which cause a great deal of trouble in the mint field. If plowing is deferred until spring it should be done as soon as the land is dry enough for field work. The midwestern muck lands may be plowed in the fall even following clean tillage, if that is more convenient. However, lands in the mint-growing districts of the West which are subject to winter and spring flooding are not generally fall plowed, because of the greater danger of soil washing.

After plowing, the field is disked and thoroughly harrowed. If the soil is loose and dry, the field is frequently rolled to firm it. If the field is fall plowed, disking it in both directions at planting time may be necessary to get it into the best condition.

PROPAGATION AND PLANTING

New fields are generally started by stolons, although sometimes young plants are used. Stolons for planting are obtained from a field previously selected for the purpose—usually one that was planted during the preceding spring. On the muck soils of the Pacific coast district stolons are frequently dug from older fields where the plants have spread and where the soil is crowded with stolons. If a new grower is getting his start from an established grower in the same locality, he usually buys a designated area in the field and does the digging and hauling himself.

If stolons are bought from distant points the grower usually packs them in grain sacks and ships them with as little delay as possible. Even under the best conditions there generally will be some loss—from decay, if shipped *too* wet, otherwise from drying out. The price of planting stock depends

largely on demand. When oil prices are high the demand for stock is usually brisk, and this naturally increases its price. New growers usually purchase only sufficient planting stock for a few acres and in subsequent years enlarge their plantings from their own stock at comparatively little cost.

The quantity of stolons required to plant an acre depends on the spacing in the furrows and the distance between rows. An acre of well-established mint in which there has been no winter damage will frequently yield enough stock to plant 20 acres, but on the average only enough for 10 or 15 acres. When the entire stand is taken from a crowded field, a great yield of stolons is obtained. About 20 sacks of stolons as packed for shipping are required to plant an acre.

The removal of stolons from the ground is accomplished in different ways. They may be plowed out or dug with a potato digger and then shaken out of the loose soil with pitchforks. When removing an old crowded stand in its entirety—a fairly common practice on the Pacific coast—the field is cut into blocks about 18 inches square. For this operation, a horizontal blade attachment is drawn through the soil. The stolons are deposited in convenient piles which must not be too large or the stolons will heat and spoil. The vitality of the stolons is easily reduced if they are permitted to wilt through exposure to sun or wind. The approved practice is to cover the piles with dirt or other material if the stolons are not to be planted immediately.

As a rule, mint becomes established with little difficulty if the stolons are in good condition when planted and if the growing conditions are favorable. To give the crop a good start, stolons are planted as early as conditions warrant. In the West, growers usually begin early in March, but in Indiana and Michigan the muck lands are not generally in workable condition until a month or more later. The ground should be reasonably warm and not too wet. Prolonged cold and wet weather immediately after planting frequently causes the planting stock to rot. On the other hand, in planting before the danger of frost has passed, warm weather sometimes forces early growth after which a late spring frost may do much damage. While the destruction of this new growth by frost does not kill the stolons, it depletes their strength and frequently prevents a full crop from developing.

Planting in a very dry soil is inadvisable, especially if there is no prospect of an early rain. In order to retain as much moisture as possible, the furrows should not be laid off faster than the planting proceeds, so that the stolons may be laid in the slightly damp soil and covered immediately.

When starting new fields with young plants, the transplanting can be done under reasonably favorable conditions after permanent warm weather has arrived. In a well-established mint field innumerable young plants that come from the joints or nodes of the stolons will appear in spring. When these are about 4 or 5 inches high they can be pulled readily out of the ground, especially out of muck soil, and will have a small cluster of roots at the base of the stem.

The use of young plants instead of stolons for starting a mint field has certain advantages. The planting can be undertaken late enough in spring to avoid the cold weather that so frequently retards or even destroys young growth from stolons. The lateness of the season may prevent successful replanting with stolons, but young plants can be used to advantage. It is thus possible to obtain full production from an acreage that would otherwise be unproductive or be abandoned because of

FIGURE 5.—Mint field, in which the foreground is weed free, and the middle background very weedy; such weeds would ruin the quality of the mint oil distilled.

a poor stand or a poor condition of plants.

At present, both stolons and plants are planted chiefly by machine, especially on the large mint farms, although some of the smaller plantings are still done by hand. A number of machines, such as are used for transplanting tomatoes and cabbage, make it possible to open the furrow, set the stolons or plants, and cover in one continuous operation. Machines make possible planting from one to several rows at a time. The most widely used machines are drawn by a tractor and carry workmen—two to a row—who alternate in placing the planting stock in the freshly opened furrow just ahead of the covering operation.

Planting by hand is economically feasible only for the beginner or small-scale grower. By this method, a workman lays off 4- to 6-inch furrows about 3 feet apart, keeping not too far ahead of the setters, so the furrows will remain moist until planting is completed. Carrying planting stock in a sack hung from the shoulder by a strap, the worker drops stolons lengthwise and end to end into the furrow—or drops plants, roots down, every 12 inches. With one motion of the foot, he covers the planting with soil and packs it in. The rows may be further covered, if necessary, with a shovel plow or, when stolons are planted, with a leveler. While an expert plant-setter may set an acre, or nearly so, in a day, inexperienced workers will do well to plant half an acre. Deep loose soil, or off-condition planting stock that calls for selection, will retard the operation.

CULTIVATION

The mints require thorough cultivation to prevent the growth of weeds (fig. 5). Frequent use of fine-toothed harrows and weeders or rotary hoes (figs. 6 and 7) is recommended on both old and new fields. These implements do little damage to mint plants up to 5 or 6 inches in height. They are an efficient means of weed control if used often when the weeds are small. New fields are cultivated between the rows with ordinary cultivators until the spread of stolons into the open spaces makes further tillage inadvisable. Weeding must then be done by hand.

Second-year and older fields are worked with spring-tooth cultivators or harrows as early in the season as possible. This loosens the soil and at the same time destroys many of the weeds. If stolons are abundant and the new growth is dense this practice may be continued for some time. The thinning that results from the use of such implements is beneficial to the crop. It enables the plants to grow bushier and develop a larger proportion of leaf surface—the principal location of oil glands. Otherwise the stand has a tendency to become too thick. Cultivation cannot be continued long enough to control the weeds completely unless the field has been kept clean in the preceding year. Hand weeding is therefore usually necessary, and weeding crews are

FIGURE 6.—Weeder of the type commonly used on mint plantings.

sent through the fields several times during the summer to remove the weeds that are most likely to reduce the quality of the oil.

Nettles, marestail, pigweed, ragweed, and smartweed are common and objectionable. Some weeds color the mint oil, others contain oil with pronounced odors and are particularly to be avoided. Various grasses frequently cause considerable trouble under the conditions usually found in older mint fields. Although these may not affect the oil unfavorably to the same extent as the weeds mentioned, they are difficult to eradicate, since most of them are perennials and spread rapidly by means of rootstocks.

To keep down the weeds and grass in second-year or older plantings, sheep are sometimes used in western Oregon, beginning about June 1. They will not bother the mint unless other plants are scarce or the mint is small. Lambs and yearlings are preferred for weeding because sheep that are kept on the fields for several years become accustomed to the mint and may eat a considerable quantity. The usual rate is one sheep per acre.

After the mint crop has been harvested, the fields receive no further attention until in late fall, unless some fertilizer is added.

In the case of spearmint the fields frequently are not plowed until spring, since the stolons of this mint are deeper in the ground. In the Pacific coast district fall plowing is recommended only on land that does not wash during heavy winter rains or spring overflows.

FERTILIZERS

Manure and commercial fertilizers are used by mint growers in all areas of production and usually give substantial increases in the yield of oil where the soil is not naturally fertile. In most cases fertilizer applications apparently do not affect the quality of the oil except through effect on the maturity of the plants. The kind of fertilizer used and the rate of application depend on the type of soil, preceding crop, and management practices followed in the particular locality.

On the highly organic muck soils in Michigan and Indiana growers use fertilizers relatively low in nitrogen and high in phosphorus and potash. Three to five hundred pounds per acre of 3–9–18 (percentage of nitrogen, phosphorus, and potash, respectively), 0–10–20, or 0–20–20 are fertilizers commonly recommended for first-year mint. In cool, wet seasons 100 pounds per

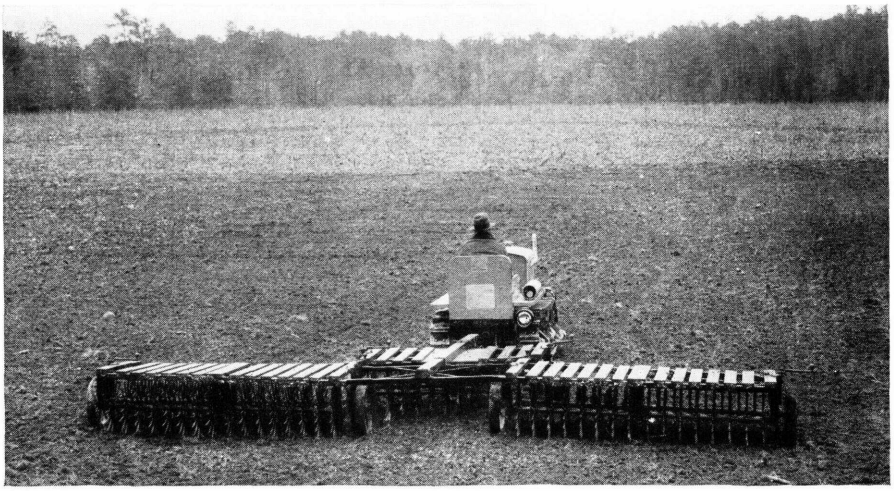

FIGURE 7.—Rotary hoe of the type used for cultivating mint.

acre of a nitrogen fertilizer such as sodium nitrate or ammonium sulfate is added to give the plants a start. Established plantings are commonly given a topdressing of 250 to 500 pounds per acre of 2–8–16 fertilizer broadcast and harrowed in.

Nitrogen is the principal fertilizer ingredient needed by mint grown under irrigation in the sandy-loam soils of eastern Washington and Oregon. Ammonium sulfate and ammonium nitrate are the fertilizers commonly used as sources of nitrogen and the rates of application are adjusted so that about 120 pounds of nitrogen is applied per acre. Approximately 600 pounds of ammonium sulfate or 350 pounds of ammonium nitrate contain 120 pounds of nitrogen. If other nitrogen fertilizers are used the rates of application are similarly adjusted depending upon the nitrogen content of the material. Phosphorus is not included in the fertilizer for mint unless a soil analysis has indicated that the phosphorus level is low in a particular field. Manure is also used alone or in combination with commercial fertilizers on the mineral soils of the Pacific Northwest. If used on muck soils it may reduce the yield in dry seasons. Manure applied to mint fields should be well rotted (free from viable seeds) so that the weed problem will not be increased.

Fertilizers should be applied to new fields before the mint is planted. In the case of established plantings the applications should be made in February.

IRRIGATION

The mints require considerable water throughout the growing season. This makes it necessary to resort to irrigation in one form or another in some of the regions in which the crop is grown. The crop requires 50 to 60 inches of water in south-central Washington and eastern Oregon, where there is little summer rainfall. Beginning early in May, therefore, furrow irrigation is used at intervals of 1 or 2 weeks, depending on the prevailing conditions. The first-year mint is irrigated by means of a single furrow made between the rows. For meadow mint shallow ditches or rills are made about 30 inches apart with implements designed for the purpose. The furrows are often made

where the row was originally planted.

In some localities in western Washington and in the Willamette Valley in Oregon the usual practice is to irrigate the crop with sprinklers one to five times during the season, according to need. On muck soils that have been ditch drained, subsoil irrigation by raising the water level with ditch gates is a practical way of providing water to the root system as needed.

DISEASES AND PESTS

The mints are subject to attack by three serious diseases—anthracnose, verticillium wilt, and mint rust—all caused by microscopic fungi—and to attack by insect pests, particularly the mint flea beetle.

ANTHRACNOSE

Anthracnose (caused by the fungus *Sphaceloma menthae*), originally called leopard spot, has been very destructive at times, especially in Indiana. The first symptoms of anthracnose are small brown sunken spots on young stems and stolons (fig. 8). These areas enlarge and become oval, with a light, ash-colored center surrounded by a dark-reddish border. Often the spots come together, forming large cankers that may cause the stem to crack. Heavy infections may kill young stolons and stems.

The leaves also are attacked. On young leaves small brown spots can be seen from both sides. In later stages these spots become round and light brown with a dark margin. Sometimes the centers fall out, giving a shothole appearance. The infected plants are weakened and young tender tissue often is killed, resulting in lower yields of oil. Anthracnose may be especially severe on the new shoots that come out after the mint is cut, and plants thus weakened may fail to overwinter.

The organism causing the disease overwinters mainly on old mint refuse and not in the soil. Some control is reported by the frequent application of a 20–80 copper-lime dust or by spraying about six times during the season with a 3–3–50 bordeaux spray. The most practical and economical means of control, however, seems to be to plow under the old mint in the fall. It is advisable to equip the plow with trash shields, so that all of the old mint is covered. Stolons that are buried thoroughly rarely produce plants that are infected, even if the stolons came from plants infected the year before. When new fields are planted, disease-free planting stock should be used if obtainable, since the disease is introduced into new localities on infected planting stock. Anthracnose is apparently not an important disease in mint fields in Michigan.

VERTICILLIUM WILT

Verticillium wilt (caused by *Verticillium albo-atrum* var. *menthae*) is a serious disease in Michigan and Indiana and has been reported in Oregon. Many acres of good mint land in Michigan are not planted to this crop because of the presence of wilt. The disease first appears in May and June. Affected plants are dwarfed and may show uneven growth, and the top leaves are bronze colored. Later in the season the plants become progressively yellow, usually starting with the lower leaves and advancing upward with the organism. During dry weather affected plants die rapidly.

Control of wilt is difficult because the verticillium organism remains in the soil for long periods. Crop rotation has thus far been of little value in control, since growers have reported instances where mint was not planted on wilt-infested soil for many years but as soon as those fields were used for mint again the planting became infected. The se-

FIGURE 8.—Anthracnose (leopard spot) of mint, showing typical spotting of stems and leaves.

riousness of the disease can be reduced somewhat on muck lands by maintaining the water level at 18 to 20 inches where this is possible with the aid of gates in the drainage ditches. In the case of spearmint the disease usually develops late enough in the season for most of the crop to be saved by cutting as soon as wilt begins to appear.

The most promising method of control appears to be in the development of types of mint resistant to verticillium wilt. All varieties of peppermint and spearmint grown commercially are reported to be susceptible, but other mints are known to be resistant, and these may be useful for the development of disease-resistant types. At present no resistant types are available for commercial production.

Since the disease was discovered in Michigan in 1924, it has spread rapidly to other mint-producing areas, mainly through the use of infected planting stock. *Growers who are planning to start mint culture in new areas should take special precautions to secure wilt-free material for planting.*

Further information on verticillium wilt is contained in Technical Bulletin 221, Verticillium Wilt of Peppermint, issued by the Michigan State College Agricultural Experiment Station. Copies may be purchased from the Station at East Lansing, Mich.

MINT RUST

Mint rust (caused by *Puccinia menthae*) is becoming increasingly important in the United States. It causes serious losses at times on peppermint in Oregon and on spearmint in Indiana and Michigan.

In spring and early summer the disease appears in the form of light-yellow to brown raised spots on deformed stems and leafstalks and sometimes on the main leaf veins. In summer and fall golden or cinnamon-brown to dark chocolate-brown spots are found on stems and leaves. Rust may reduce the oil yield, since badly diseased leaves curl and die and the quantity of oil in other infected leaves is reduced. When rust begins to be serious it can be controlled by dusting with sulfur or spraying with bordeaux mixture. Early cutting is recommended on fields that have become badly infested.

INSECT ENEMIES

The mint flea beetle is the most important insect pest of mint. The adult eats small holes in the leaves, sometimes causing a considerable leaf-fall and browning of the plant, and may feed on the stems. During the hottest part of the day the beetles collect on the undersides of the leaves and stems or in the shade on the ground. Beetles alighting on the soil in the direct sun may be killed by the extreme heat.

Mint flea beetles can be controlled to some extent by crop rotation or summer fallowing. Under either of these practices the fields and surrounding ground should be kept clean of any volunteer or wild mint, as beetles will survive on these.

The adult flea beetles usually appear sometime during July in the mint-growing areas and, after feeding for about 3 weeks, they mate. Shortly thereafter the females begin depositing eggs on or in the soil and continue until the beginning of cold weather. Dusting of the crop should be started when damage by flea beetles is first noticed; this will prevent damage to the crop and reduce the number of eggs laid. In some seasons the time for dusting may coincide with harvesting operations. When this happens, it is advisable to cut the mint slightly earlier and then treat the stubble.

Flea beetles may be controlled on the growing crop or on the stubble by applying a dust containing 5 percent of DDT at the rate of 25 to 30 pounds per acre. The following

dusts are also effective against these pests on actively growing mint: Cryolite, containing 50 percent sodium fluoaluminate at the rate of 25 to 30 pounds per acre; calcium arsenate diluted with 5 to 10 percent of bentonite; or dusting clay at 15 pounds per acre. Several applications may be required to control an infestation.

The spent hay must not be used for cattle feed if poison has been used on the crop.

Mint is subject to attack by several minor insect pests, such as cutworms, grasshoppers, strawberry root weevils, black vine weevils, and wireworms. Growers are advised to request information from their State agricultural experiment station regarding these insects and methods for their control.

HARVESTING

It is generally assumed that the quantity and quality of oil in mint reach a peak at the flowering stage. In the Pacific Northwest where an extended growing season and long days with much sunshine contribute to early flowering and high production in mint, the crop is usually harvested at the full-bloom stage. In the Middle West, where mint, particularly meadow mint, flowers sparsely in some seasons, it may be necessary to harvest before flowering begins. Growers must rely on experience under these conditions to determine the proper time to cut the crop. A few growers run trial distillations and then apply a test for menthol that indicates the proper stage for harvesting. Details of the test can be obtained from the Purdue University Agricultural Experiment Station, Lafayette, Indiana, where it was developed.

The mints normally reach the best stage for harvesting during July in California; the time ranges through August, or sometimes well into September, elsewhere. However, unusual weather may advance or delay the harvest by as much as several weeks. In the West two harvests are frequently obtained. California's growing season is long enough to mature two crops, but in Washington and Oregon it is generally necessary to cut the first crop before it reaches its optimum development if a second cutting is to be obtained before the onset of heavy rains. Heavy rainfall reduces the oil yield and interferes with curing in the field.

A rank growth on fertile muck soils is likely to remain damp for long periods and shed lower leaves before the best harvesting stage is reached. To avoid this and to develop a reasonably productive second crop, it is better to cut the crop early. The two-crop practice, however, is of doubtful value, even if the yield of oil is larger, unless the seasonal conditions make it possible to cut both crops at the proper time. The oil obtained from too early cutting is frequently of inferior quality and is lacking in the characteristics demanded by the market.

Both row and meadow mint are harvested with sickle-bar mowers, the sickle bar being fitted with a vine lifter. As row mint is cut one row at a time, the regular sickle bar must be shortened accordingly.

After the mint is cut it is allowed to lie in the swath a day or so until partially cured, when it is raked into windrows with a side-delivery rake. It is best to carry out this operation early in the morning while the mint is still tough. If the weather is fair and drying proceeds rapidly, the herb may be hauled from the windrows to the still. In dull weather it is frequently necessary to place it in small cocks like hay, to continue the curing. Some growers prefer this method as a regular practice. Others find it more economical to load directly from the windrow with hay loaders. Complete dry-

ing makes the herb brittle and should be avoided. In such condition it cannot be handled without loss of foliage and a resulting loss of oil.

The ordinary flat hayracks or specially constructed wagons with high sides are serviceable for hauling the herb. The material can be loaded onto these with the least labor and a minimum of shattering. It is generally hauled as loose hay and transferred to the tubs by pitchfork or some form of hayfork, crane, and windlass.

Some growers whose operations are large haul the cured mint in metal forms (tubs), usually larger than the distillation vat, on low-bodied trucks. They first place a sling in the form and then pack the herb firmly in it. At the still the entire sling load is lifted by crane or track hoist and dumped into the distillation vat, filling it quickly in a single operation—and without the usual leaf shattering.

Mechanical choppers for loading mint in the field have been developed recently. The partially dried mint hay is picked up from the windrow, chopped, and blown into wagons or portable distillation tubs. This method makes it possible to process from one-third to one-fourth more material per tub of equivalent size than is possible when unchopped hay is used.

DISTILLATION OF THE OIL

The process employed for removing the oil from mint consists of passing steam through the herb, thus vaporizing the oil. The steam and oil vapors are conducted through a worm or other form of condenser, where they are reduced to water and oil. The water and oil are collected in suitable receivers, in which they separate into layers, the oil floating on the surface. Although the equipment used for this purpose has been gradually improved, the method of operation has on the whole remained unchanged.

DESCRIPTION OF STILLS

A distilling unit consists of a high-pressure boiler for generating steam, a tub, a condenser, and a receiver. The general arrangement of these several parts may vary according to conditions, but the whole equipment should be so assembled that the outfit can be installed at the lowest cost and operated with the greatest saving of labor. Generally even the smallest distilling units include two tubs operated with one condenser, so that one tub can be charged while the other is in operation or is being discharged. On the larger farms four or more tubs are usually operated in pairs, with a condenser for each pair. Sometimes a single large condenser is adequate for as many as four tubs.

Most boilers are operated at a steam pressure of 85 to 100 pounds. The efficiency of a distillation plant depends largely on having an ample supply of steam; boilers should deliver enough steam to process the largest amount of mint to be handled.

All stills, regardless of the purpose for which intended, must be registered with the United States Internal Revenue Service. Applications for the required blank forms should be made to the Director of Internal Revenue of the district in which the still is to be operated. Also, in most States, periodic inspection of steam boilers of the kind used on mint farms is legally required.

Tubs

Since it takes less time to discharge and reload a tub than to complete the distillation, a more efficient arrangement in a multitub unit is to equip each tub with its own condenser. This makes it possible

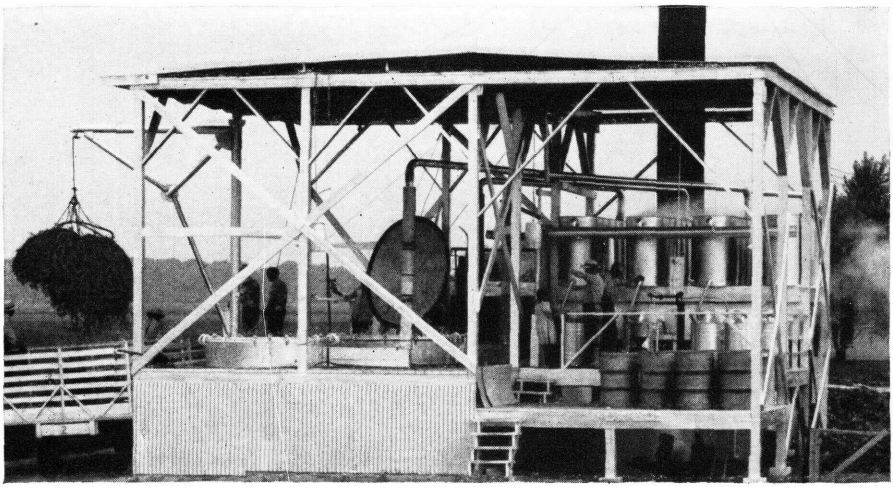

FIGURE 9.—Modern mint still, with a condenser for each tub. The herb is placed in a steaming tub (lower left), from which oil and water vapor pass to a condenser (upper right); the oil and water flow in liquid form to a receiver (oil separator), from which the water is drawn off as necessary and the oil is made to pass into a drum (lower right). For operation of oil receiver (separator) see figure 14.

to keep the tubs in more nearly continuous operation and to eliminate some heavy iron pipes and valves that sometimes cause discoloration of the oil. Such a still is shown in figure 9.

The tubs are set down part way in a platform, which serves as a working floor, the tubs projecting usually about 2 feet above this floor. A windlass is mounted on a crane or track in such a position that it can be used for loading and discharging all tubs.

The tubs in use vary somewhat in size. They are 6 to 9 feet deep and 6 to 7 feet in diameter, most of them measuring 7 feet in both directions. Some are made slightly larger at the top than at the bottom to facilitate the removal of the spent herb. In the early years of the industry they were constructed of wooden staves. At present cement tubs are used in some sections of the Pacific Northwest, but elsewhere most of them are made of No. 16 gage galvanized steel (fig. 10). The steamtight gasket consists of a flat strip of composition material riveted to the rim of the tub or to the underedge of the cover, which is fastened down by means of adjustable eccentric clamps.

The steam is admitted from a 1½-inch pipe just above the bottom of the tub. An even distribution of steam through the charge is effected by means of a T with open ends. The outlet for the steam and oil vapors is through a pipe from the side just below the cover. This pipe has a diameter several times as large as that of the inlet pipe, in order to prevent pressure from building up

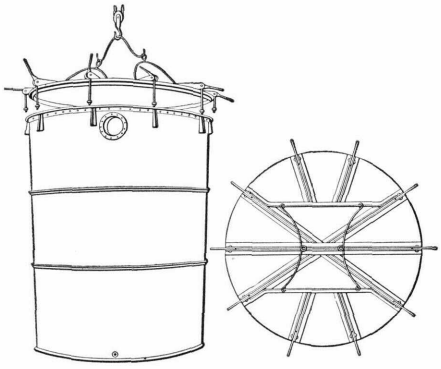

FIGURE 10.—Galvanized-steel mint tub of the type commonly used.

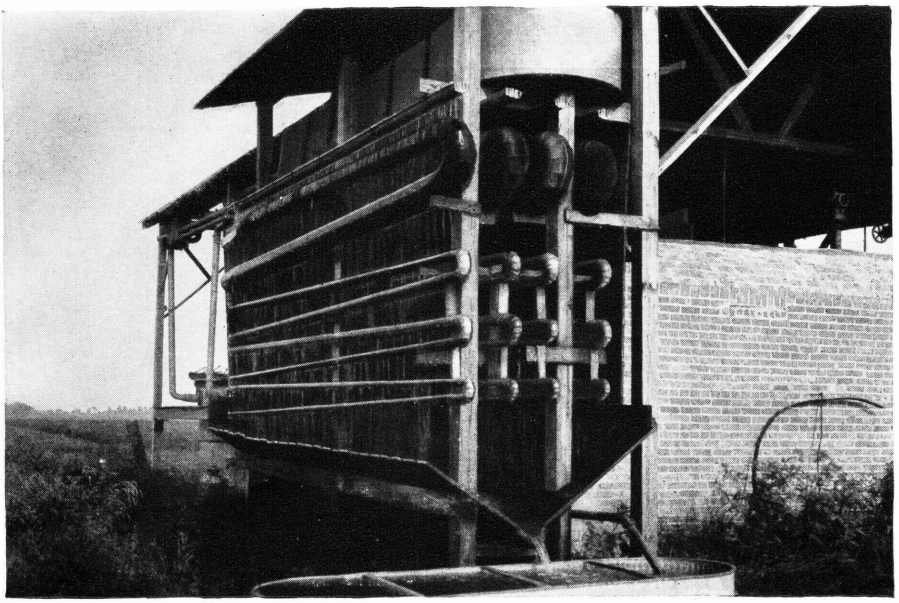

FIGURE 11.—Worm-type drip condenser used in the distillation of mint.

in the tub. It usually extends upward and then passes overhead to the condenser.

Some metal tubs used in the Pacific Coast States are fitted with an open collar around the rim about 5 inches wide and 10 inches deep. This collar holds water. The cover has a turned-down edge that fits into the collar, thus making a water seal. The vapors leave the tub through a gooseneck from the center of the cover and are conducted to the condenser. The union of the exit pipe and condenser is also sealed with water by a similar arrangement. When the charge in the tub is exhausted the cover is lifted by means of a hoist and swung over for use with the other tub. With this type of equipment no clamps are required, but excessive steam pressure must not be allowed to develop in the tub or the cover will be forced up and the seal broken.

Condensers

The worm-type condenser has been in use for many years in one form or another. One type consists of six or eight horizontal sheet-metal pipes joined at the ends by elbows to form a continuous series (fig. 11). The first two lengths of pipe from the top are 7 or 8 inches in diameter and the rest are reduced successively in size, the last one, from which the condensed oil and water flow, being 2 or 2½ inches in diameter.

Condensation is obtained by water flowing over the pipe from a perforated trough mounted directly above the condenser. This water drains into a lead-off trough at the bottom. On some condensers a lead-off trough is mounted below the third pipe with a second perforated trough immediately below it to furnish a fresh supply of cold water to the remaining pipes. The water flows to the troughs by gravity from a reservoir overhead. A steady and ample supply of water is drawn by pumps either from wells or from small streams in the vicinity of the stills. The hot water that drips from the condenser is frequently used in the boiler, with a considerable saving of fuel. At some con-

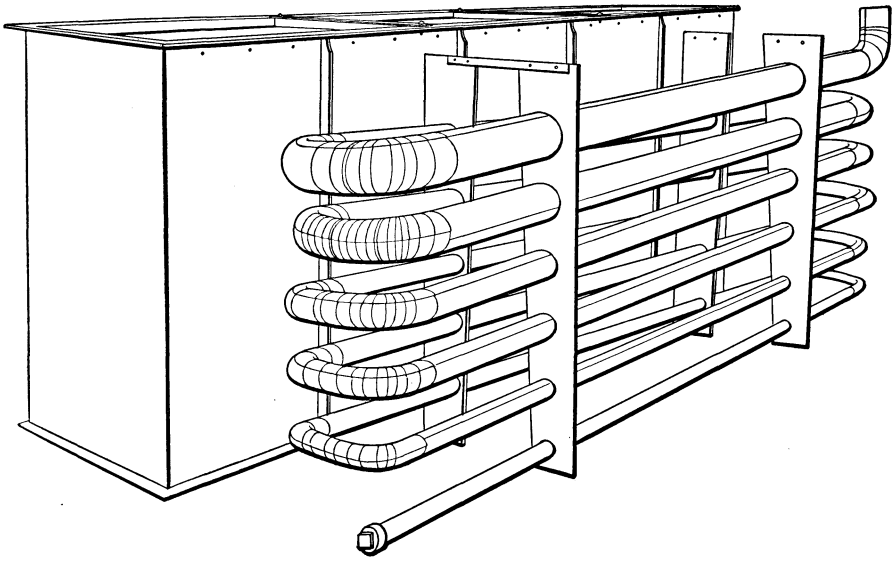

FIGURE 12.—Galvanized-steel tank-type worm condenser. When in operation the worm is inside the tank.

venient point in the upper part of the condenser is an air vent that can be opened when the steam is shut off. The air entering through it will prevent the condenser from collapsing, which otherwise is likely to occur because air cannot enter fast enough through the small end of the condenser.

The type of condenser described came into extensive use mainly because it could be constructed from galvanized sheet metal at a small cost. This material has the disadvantage that it is soon destroyed by rust. If built of copper pipe lined with tin, however, such condensers will last many years.

The drip-type worm condenser has recently been replaced largely by a tank-type worm condenser (fig. 12), having a similar worm arrangement but with the worm enclosed in a large tank. Water enters the tank continuously, so that the pipes are bathed constantly in cool water.

A few growers are using tubular condensers. These consist of an upright galvanized-steel shell in which are mounted numerous upright galvanized-iron pipes of small diameter, somewhat like the flues in a boiler (fig. 13). As the vapors pass downward through the pipes they are condensed by the cold water that circulates around the pipes, and the condensed water and oil flow from a narrow outlet into the receiver. Though rather expensive, such a condenser lasts a long time, requires little space, and is very efficient.

Oil Receivers

The receivers in which the oil is collected are of simple design and construction. They are cylindrical and made of galvanized iron and vary in capacity from 10 to 50 gallons. Since the oil floats, the water is drawn off the bottom by means of a pipe that extends up along the side of the receiver to within a few inches of the top, where it is fitted with an elbow and a short extension pipe. As distillation proceeds, the surface of the oil in the receiver is maintained at the desired level by raising or lowering the end of the

extension pipe from which the water drains. At a point near the top of the receiver is an outlet from which the oil can be drawn off (fig. 14).

A number of devices are used to prevent churning of the contents of the receiver by the flow from the condenser, since this might cause some of the oil to be drawn off at the bottom with the water. One method is to direct the flow into a

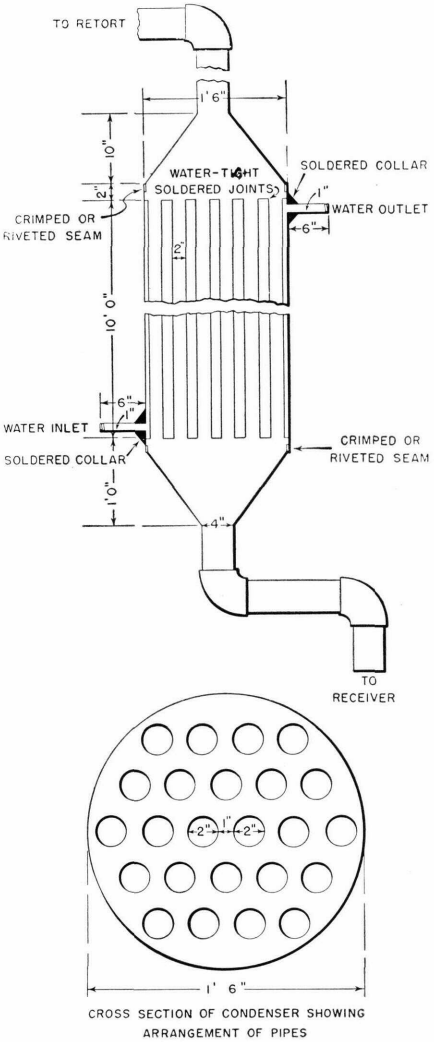

FIGURE 13.—Details of a tubular condenser.

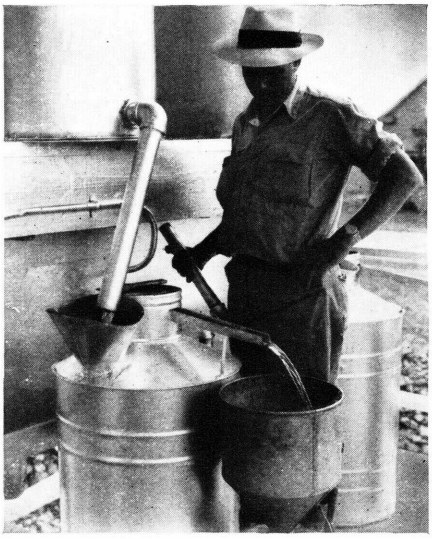

FIGURE 14.—Removing peppermint oil from the receiver. The operator has brought the oil level up to the discharge spout by raising the extension pipe of the water outlet.

funnel-topped pipe that extends about half the distance to the bottom of the receiver, where it is fitted with a short return elbow that directs the oil toward the surface.

Another method is to admit the flow from the condenser into the receiver through a pipe at a point about two-thirds the way down, a baffle plate immediately below the inlet directing the separated drops of oil toward the surface.

OPERATION OF STILLS

When a tub is charged, the herb is packed down thoroughly (fig. 15) so that the steam will pass uniformly through the charge instead of channeling, as is likely to occur in loosely or unevenly packed material. An iron ring or a crosspiece with chains attached is placed on the bottom, and when the tub is half full the chains are laid across the charge and the steam partly turned on. A second ring is then introduced and the loading completed. By means of these rings

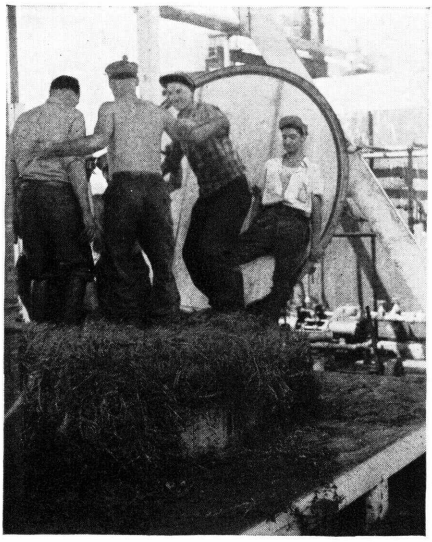

FIGURE 15.—Packing a tub with mint hay preparatory to distilling.

and chains and a crane the spent herb is easily removed from the tub in two batches. The slow admission of steam, while loading is in progress, makes it possible to pack the herb more firmly. After the cover has been clamped down, more steam is turned on, and when the condensed vapors of steam and oil begin to flow from the condenser the admission of steam is so adjusted that condensation is complete, with no loss of oil vapors.

The time required to exhaust a charge depends on the quantity of steam admitted and the condition of the herb. The drier the herb, the shorter the time required. Steam coming in contact with green herb is partly condensed, and a much longer time is therefore required to complete the operation. In most cases, if the herb has been well cured, the steaming is continued for about 45 minutes or an hour. During this period the second tub is emptied and reloaded (fig. 16).

The exhausted material is deposited on wagons or trucks by means of a crane and hauled away. If spread out on the field and properly dried it makes excellent fodder and is commonly used for this purpose. It is relished by all kinds of livestock and in feeding value is reported to be equal to timothy hay. It is also used to advantage as a fertilizer, and when intended for this purpose is spread on the field and plowed under in fall. At times some growers deposit the refuse on large dumps, where it is allowed to decompose before being spread on the field.

As a rule the oil separates readily from the water in the receiver and if carefully removed is entirely clear. Some growers prefer to filter it before storing, but this is not usually necessary. The oil may be stored in 5- or 10-gallon tin cans, or, if large quantities are produced, in heavy 40- or 50-gallon galvanized drums or aluminum kegs. Rectifi-

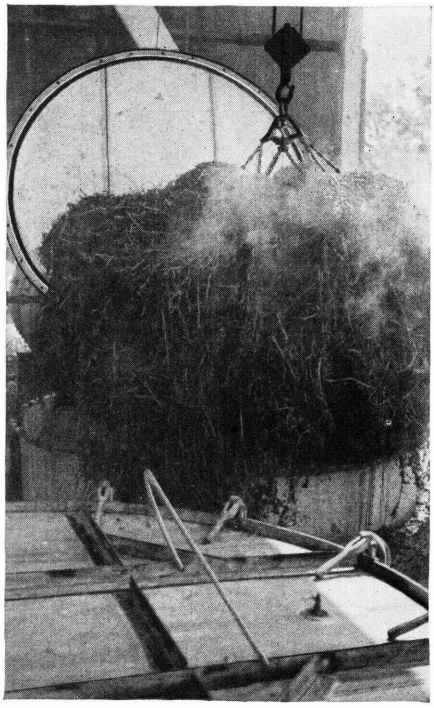

FIGURE 16.—Removing the spent hay from the tub after distillation has been completed.

cation by a second distillation is not generally required unless the oil is highly colored, is of unusual composition, or is intended for use where only rectified oils are permitted. Generally, if the fields have been kept free from weeds and the distillation has been carefully conducted, the oil obtained is acceptable to the trade. Rectification usually cannot be undertaken to advantage by the average grower, although it is frequently done by large producers.

Both peppermint and spearmint oils may be kept for an indefinite period without material change in quality, if the moisture is removed and the oil is stored in a cool place in completely filled clean tin cans or drums with tight closures.

ECONOMIC FACTORS IN MINT FARMING

YIELD OF OIL

The yield of oil from mints varies greatly with season and cultural conditions and geographic location. The average yields in the principal mint-growing States during the 10-year period, 1941–50, and for the years 1951 and 1952 are shown in table 1, page 2. Since the figures given are averages, it may be assumed that some farmers are getting better, others poorer, yields than indicated.

The yield is reduced greatly if the plants are too thick in the field to permit full leaf development or if many of the lower leaves have fallen off on account of the continued dampness due to thick stands. Clear sunny weather during the few weeks immediately preceding the harvest causes the herb to develop more oil than it will in cloudy, wet weather. Heavy rains at harvesttime wash off considerable amounts of oil, and rough and excessive handling when the herb has been permitted to become too dry also causes loss through the shattering of leaves.

PRICE OF OIL

The prices received by farmers for peppermint oil averaged $5.65 per pound in the 10-year period, 1941–50, $6.52 in 1951, and $5.74 in 1952. The average prices received in the principal States in 1951 and 1952 are given in the following tabulation:

State:	*Average price* 1951	1952
Indiana	$7.00	$6.90
Michigan	6.95	6.95
Wisconsin	7.00	6.80
Oregon	6.50	5.90
Washington	5.95	4.35

Prices for spearmint oil averaged $3.81 per pound in the 1941–50 decade; $5.08 in 1951; and $6.94 in 1952. The average prices in the two principal producing States were: Indiana, $5.00 in 1951 and $6.90 in 1952; and Michigan, $5.20 in 1951 and $7.00 in 1952.

CAPITAL INVESTMENT AND PRODUCTION COSTS

Equipping a farm to distill mint and raising the crop are expensive. Equipping for the distilling operation, in particular, should not be undertaken lightly. The new grower would do well to arrange, if possible, to have his first crop or two distilled by an established operator in the neighborhood. In that way he can defer the investment until he has found that he can grow the crop successfully and has gained some familiarity with the equipment. The cost will vary considerably, depending on the location and whether equipment is bought new or secondhand. The boiler, which is the key to efficient operation and the most expensive item of equipment, can sometimes be bought secondhand at a considerable saving. The new equipment for a two-tub still cost $2,000 to $4,000 at 1947

prices, and larger units at the rate of about $1,000 per additional tub. The additional capacity is rather expensive because the multitub unit requires a correspondingly larger boiler. Naturally, a large enough boiler for any anticipated expansion should be purchased at the start.

The cost of growing, harvesting, and distilling peppermint and spearmint fluctuates with price of planting stock, wage scales, and other local conditions. The costs vary greatly among farms, but labor is the greatest single factor.

In an Indiana study the average cost per acre of producing peppermint oil was found to range from about $37 to $51 in the 4-year period 1936–39, or $1.50 to $1.90 per pound of oil when average yields were obtained. Approximately 50 hours of man-labor per acre were required. Labor costs represented 30 percent of the total cost in the first year of the crop and 25 percent in subsequent years. Weeding required 40 to 50 percent of all the labor needed.

In a 1947 study, the cost of growing, harvesting, and distilling the crop from an acre of peppermint in the irrigated sections of Washington was found to average $245, or $3.25 per pound of oil produced. Manure and fertilizer practices represented nearly one-third of the total growing cost. Cultivation, including hand weeding, was the second most important cost item, representing about 25 percent of the total.

U. S. GOVERNMENT PRINTING OFFICE: 1954